Reinforced Concrete Masonry Design

AN APPLICATION GUIDE

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MIA
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Allowable Stress Design

3.0 General

The theory on which the allowable stress design method is based is the same elastic theory on which the reinforced concrete working stress method is based. As in concrete, where the tensile strength of concrete is neglected, the tensile strength of masonry is also neglected.

The relatively high compressive strength of masonry is relied upon to provide compression, and tension is resisted by reinforcement. This combination of steel and masonry provides the axial, flexural and shear strength in reinforced concrete masonry structures.

The basic premise is that calculated stresses under a given combination of loads are in the elastic range. Thus, the allowable values for each material (i.e., masonry and reinforcement) are derived by dividing the yield strength by a factor of safety.

For masonry in compression, and reinforcement in tension, the factor of safety is 2.5.

Allowable stresses can be increased by one third when load combinations include wind or seismic loads along with gravity loads. However, when ASCE 7-98 load combinations are used, no increase is permitted.

The elastic theory makes the following assumptions:

1. Members are prismatic.
2. Plane sections before bending remain plane after bending.
3. Strain across the member depth varies linearly and is thus proportional to distance from neutral axis.
4. Stresses are linearly proportional to strains.

check

$$\therefore \frac{f_a}{F_a} + \frac{f_b}{F_b}$$

$$= \frac{66}{230} + \frac{359}{500} = 0.287 + 0.718$$

$$= 1.005 < 1.33; \text{ hence, OK}$$

check compression area depth = kd

= 0.27(3.81) = 1.03 inch, the neutral axis is within shell thickness because shell thickness = 1.25 inch

Therefore, vertical reinforcement is OK

Horizontal reinforcement = 0.183 – 0.11 = 0.073 in.^{2}/ft

Provide one #4 @ 32 in. o/c = $\frac{0.2}{2.67}$ = 0.075 in.^{2}/ft

Provide one #6 @ 48 inches vertical and one #4 @ 32 inches horizonal. The reinforcement is shown in Figure 3-31.

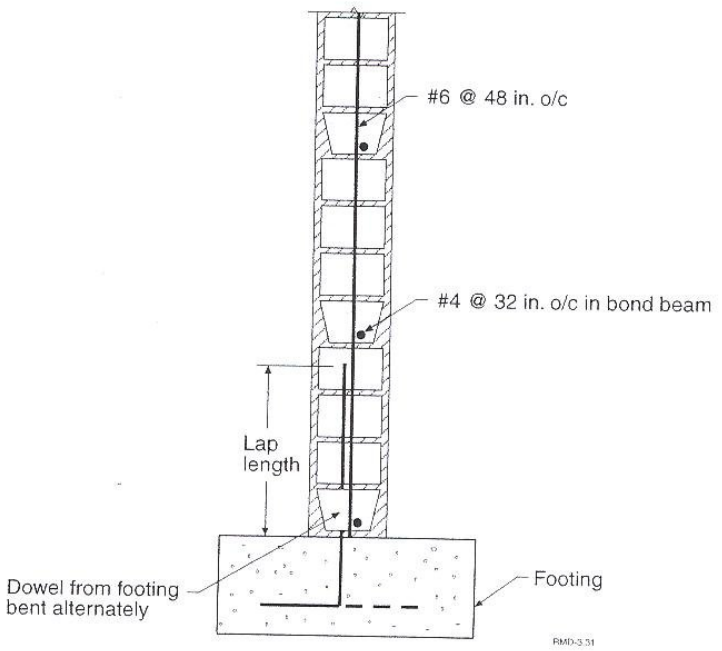

Figure 3-31
Reinforcement details

B1.1 Load reduction

When using combination of dead loads and variable loads, the variable loads can be reduced by 25 percent and added to dead load effects. Lateral earth pressure is considered a permanent load, not a variable load.

Increase in allowable stresses is not allowed when using Equations B.1 through B.6.

B.2 Alternate basic load combinations—allowable stress design (IBC Sec. 1605.3.2)

Many building codes allow an increase in allowable stresses when wind or earthquake loads are used in combination with other loads. This practice is followed by many design engineers. To account for this well-ingrained practice, an alternate load combination method is allowed. These combinations can be used instead of those given in B.1. Alternate load combinations do not exist in ASCE 7-98.

$D + L + w\,(W)$	Eq. B.7
$D + L + w\,(W) + 0.5S$	Eq. B.8
$D + L + S + 0.5\,w\,(W)$	Eq. B.9
$D + L + S + E/1.4$	Eq. B.10
$0.9\,D + E/1.4$	Eq. B.11

When using load combinations B-7 through B-11, an increase of 33.3 percent in allowable stresses is permitted when using wind or earthquake loads, combined with other loads.

When wind loads are calculated according to ASCE 7 procedures, $w = 1.3$ should be used; otherwise, $w = 1.0$ can be used.

The exception for combining snow loads with earthquake loads remains the same as in B.1.

When lateral earth pressure exists, it should be combined as 1.0 H with the appropriate combination of loads.

B.3 Load combinations—strength design

When using the strength design method, structures and portions of structures should be designed for the following load combinations:

$1.4\,D$	Eq. B.12
$1.2D + 1.6L + 0.5\,(L_r \text{ or } S \text{ or } R)$	Eq. B.13
$1.2D + 1.6L + (L_r \text{ or } S \text{ or } R) + (0.8w \text{ or } f_1\,L)$	Eq. B.14
$1.2D + 1.0\,E + f_1 L + f_2\,S$	Eq. B.15
$0.9D + (1.0\,E \text{ or } 1.6\,W + 1.6\,H)$	Eq. B.16

where f_1 = 1.0 for floor in public assembly when L > 100 psf and parking garage live loads

f_1 = 0.5 for all other live loads

f_2 = 0.7 for roof configurations that do not shed snow off the structure